ENVIRONMENTAL EFFECTS ON THE STABILITY OF OPTICAL FIBERS USED FOR REFERENCE FREQUENCY DISTRIBUTION[1]

MALCOLM CALHOUN, PAUL KUHNLE, and JULIUS LAW
California Institute of Technology
Jet Propulsion Laboratory
Pasadena, California 91109

ABSTRACT

The Frequency Standards Laboratory at the Jet Propulsion Laboratory (JPL) is responsible for the generation and distribution of ultra-stable reference frequencies in NASA's Deep Space Network (DSN). Certain assemblies and components of the Radio Science and VLBI systems are located in the cones of tracking antennas hundreds of meters from the Frequency and Timing Subsystem's frequency standards. Until recently, signals from the hydrogen maser frequency standards to the antennas were distributed by way of coaxial cables which are particularly sensitive to temperature variations as well as magnetically induced fields.

The design of the reference frequency distribution system described in this paper is based on optical fibers. The measured temperature coefficient of delay (TCD) for one type of optical fiber used in this application is less than 1 part per million per °C as compared with conventional single mode optical fiber with a TCD of approximately 7 parts per million per °C. The optical transmitter used in the distribution assembly is a commercial, single-mode distributed feedback laser diode with integral optical isolator. A companion optical receiver and distribution amplifiers are located in the cone area of the antennas.

The temperature profile from the earth's surface to a depth of six feet over a time period of six months was used to optimize the placement of the fiber optic cables. In-situ evaluation of the fiber optic link performance indicates Allan deviation on the order of parts in 10^{16} at 1000 seconds averaging time; thus, the stability of the link is not degraded by environmental conditions. Thus, optical fibers and electro-optic devices as distribution media appear to maintain hydrogen maser stability at the antenna location.

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